

**SELECTIVE FUNCTIONALIZATION OF CARBON NANOTUBE TIPS  
ALLOWING FABRICATION OF NEW CLASSES OF NANOSCALE  
SENSING AND MANIPULATION TOOLS**

**ABSTRACT OF THE DISCLOSURE**

Embodiments in accordance with the present invention relate to techniques for the growth and attachment of single wall carbon nanotubes (SWNT), facilitating their use as robust and well-characterized tools for AFM imaging and other applications. In accordance with one embodiment, SWNTs attached to an AFM tip can function as a structural scaffold for nanoscale device fabrication on a scanning probe. Such a probe can trigger, with nanometer precision, specific biochemical reactions or conformational changes in biological systems. The consequences of such triggering can be observed in real time by single-molecule fluorescence, electrical, and/or AFM sensing. Specific embodiments in accordance with the present invention utilize sensing and manipulation of individual molecules with carbon nanotubes, coupled with single-molecule fluorescence imaging, to allow observation of spectroscopic signals in response to mechanically induced molecular changes. Biological macromolecules such as proteins or DNA can be attached to nanotubes to create highly specific single-molecule probes for investigations of intermolecular dynamics, for assembling hybrid biological and nanoscale materials, or for developing molecular electronics. In one example, electrical wiring of single redox enzymes to carbon nanotube scanning probes allows observation and electrochemical control over single enzymatic reactions by monitoring fluorescence from a redox-active cofactor or the formation of fluorescent products. Enzymes “nanowired” to the tips of carbon nanotubes in accordance with embodiments of the present invention, may enable extremely sensitive probing of biological stimulus-response with high spatial resolution, including product-induced signal transduction.

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